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On colour perception in *Calandra oryzae* LINNAEUS

(Coleoptera: Curculionidae)

With 1 text figure

The author in an earlier paper (SAXENA 1961) pointed out a possibility of existence of the colour vision in *Calandra granaria*. The present paper is an attempt to investigate such a possibility in *Calandra oryzae*. Since the rice weevils respond to illuminations (SAXENA 1961), it is quite likely that they may also be able to perceive the coloured lights.

Material and Method

Experimental insects: Rearing of *Calandra oryzae* was done in the laboratory. Batches of 150 insects put in 1 lb jam jars, filled about $^3/_4$th with wheat, were kept at a temperature of 25 °C $\pm$ 2 °C and the adults which emerged out after about 35 days were used for experiments.

Experimental procedure and Apparatus: The experimental wooden box, described earlier (SAXENA 1957), in which the heat of the bulb was prevented from reaching the animals by keeping a trough filled with cold water between the source of light and experimental insects confined under glass funnels, was utilized for exposing the insects to different coloured lights. A 75 Watt bulb was hung over the trough and the ordinary water of the trough was replaced by different coloured waters, in order to get desired coloured light. The water-soluble methyl violet, methylene blue, diamine green, diamine orange and diamine red coloured dyes were used.

The response taken was the duration of thanatosis (death feigning) which has been found to vary if the insects are subjected to different physical factors including different illuminations (SAXENA 1961). To record the duration of thanatosis the experimental insects which were kept individually with food, undisturbed for 8 hours, were subjected to a mechanical stimulus, a needle, applied to thorax, resulting into thanatosis state and the duration was recorded by a stop watch (SAXENA 1961).

Prior to their exposure to the coloured lights, the experimental insects were first conditioned for 24 hours in the dark.

The square root transformation was applied to the data to normalize the distribution of data and to make the variance in any group of observations more nearly independent of the mean.

Design of Experiment

100 insects divided into 5 batches of 20 each were exposed to violet, blue, green, orange and red lights respectively at illuminations of .015, .05, .012, 1.99 & .063 Foot Lamberts respectively (Table 2).

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80 insects divided into 4 batches of 20 each were exposed to artificial light at illuminations of .6, 1.2, 1.4 & 1.8 Foot Lamberts respectively.

All the factors were kept constant and the durations of thanatosis were recorded in each case in seconds.

Results and Discussion

Table 1

Thanatosis response to different illuminations

Transformed mean response in seconds to different illuminations					
Illuminations	.6	1.2	1.4	1.8	(Foot Lamberts)
Response	2.09	1.65	1.4	1.0	(Seconds)

Table 2

Thanatosis response to different coloured lights

Transformed mean response in seconds to different coloured lights						
Illuminations	.015	.05	.01	1.99	.063	(Foot Lamberts)
(Coloured light)	Violet	Blue	Green	Orange	Red	
Response	1.02	.80	2.05	.90	2.L	(Seconds)

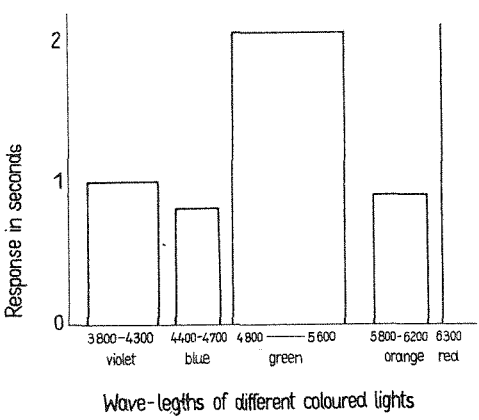

Fig. 1. Thanatosis response to different coloured lights

The weevils subjected to various coloured lights show a fall in the duration of thanatosis under blue, violet and orange lights whereas thanatosis is inaffective under green and red lights suggesting a possibility of the existence of colour perception in these weevils (Fig. 1). Violet, blue, green, orange and red lights of illuminations .015, .05, .012, 1.99 and .063 Foot Lamberts were used. The effect of artificial ordinary light of different illuminations was also studied to compare the results (Table 1). Under artificial light no effect on duration of thanatosis is recorded at low illumination whereas the duration of thanatosis falls when exposed to violet, and blue lights at low illuminations indicating that probably the weevils are sensitive to these coloured lights. These results are in accordance

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to SAXENA 1961. No change in thanatosis is noted on exposure to red and green lights. Regarding orange lights although the period of thanatosis decreases but the level of illumination was quite high (1.99 Foot Lamberts) creating doubts whether the effect on thanatosis was due to illumination or colour perception as the results show that, approximately, at this level of illumination the period of thanatosis falls even under artificial light (ordinary). Further work is thus required with this coloured light to reach a decision. Several entomologists KUHN & POHL (1921), HESS (1910), PETERSON & HAEUSSLER (1928), and GUI et al (1942) have reported the sensitivity of other insects to coloured lights. According to MAST (1917) the region in the spectrum of maximum stimulating effeciency is either in the blue or in the green for all organisms. LUTZ's (1924) conclusion that many insects react positively to red, green, yellow, blue and ultraviolet lights and that they see ultraviolet better than other radiations was mentioned by WEISS (1943) in his review of the literature on colour perception. The results of the present experiments that the insects are most sensitive to the coloured lights of the shorter wavelengths, agree with the findings of BERTHOLF (1931 and 1931a), HALLOCK (1936) and WEISS (1943 and 1943a).

FOREL (1908) and HESS (1910), as mentioned by WEISS (1943 & 1943b), suggested that the insects have no colour discrimination but are sensitive to different degree of brightness and that the shorter wavelengths appear brighter to them than the longer ones. It would be necessary to compare the energies associated with irradiation by the lights actually used to decide what part is played by sensitivity of perception and what by brightness of light of different wavelengths but the low values for illumination by violet and blue lights suggest that the weevils are peculiarly sensitive to light of these wavelengths. According to the interpretation by WEISS (1945) of visibility curves obtained by HECHT & WILLIAMS (1922) the stimulation of a single visual sense cell by light depends upon the absorption spectrum of the primary photosensitive substance. The absorption of light by this substance varies with wavelengths and the production of a given response needs a certain amount of photochemical change which in turn requires the absorption of a definite amount of energy. Differential sensitivity among optic nerve fibres and the sensory cells for different regions of the visible spectrum has been found to exist in the eye of Limulus by GRAHAM & HARTLINE (1935) and according to these authors it may be considered a peripheral mechanism of colour vision. It is also true that the shorter wavelengths of light contain a greater amount of energy than the longer wavelengths.

Summary

On account of the effect on the duration of thanatosis at the low level of illumination by coloured lights at which even exposure to ordinary artificial light should have had no effect, it appears that *Calandra oryzae* is able to perceive violet and blue lights. Also exposure to orange light shortened the duration of thanatosis, but since in this case the level of illumination was high, further studies are suggested to determine whether the effect was due to perception of orange light or to the higher level of illumination. These weevils do not appear to perceive green and red lights.

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Zusammenfassung

Angesichts der Wirkung farbigen Lichts auf die Dauer der Thanatose bei einem so niedrigen Beleuchtungsgrad, daß selbst die Behandlung mit gewöhnlichem Kunstlicht keine Wirkung hätte haben dürfen, muß man annehmen, daß *Calandra oryzae* in der Lage ist, violettes und blaues Licht wahrzunehmen. Auch die Behandlung mit organgefarbenem Licht verkürzte die Dauer der Thanatose, da aber in diesem Fall der Beleuchtungsgrad hoch war, werden weitere Untersuchungen vorgeschlagen, um zu klären, ob die Wirkung von der Wahrnehmung des organgefarbenen Lichts oder von dem höheren Beleuchtungsgrad herrührt. Grünes und rotes Licht wird von diesen Käfern anscheinend nicht wahrgenommen.

Резюме

В виду влияния цветного света на длительность танатозы при такой маленькой степени освещения, при которой не должен бы иметь и нормальный искусственный свет никакого влияния, надо принят, что *Calandra oryzae* имеет способность регистр ровать фиолетовый и синий свет. Обработка с оранжевым светом тоже укращалс длительность танатозы, но так как при этом степень освещения была высока, предлагаются дальнейшие исследования чтобы выяснить, возникает ли влияние от регистрации оранжевого света или от высшей степени освещения. Зелёный и красный свет повидимому не регистрируется этими жуками.

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